Clinical Kidney Journal, 2022, vol. 15, no. 1, 165–167

doi: 10.1093/ckj/sfab165
Advance Access Publication Date: 7 September 2021
Exceptional Case

EXCEPTIONAL CASE

Recovery of severe dialysis disequilibrium syndrome with uncal herniation following therapy with mannitol, hyperventilation and hypertonic saline

Kuan-Hung Liu [1,2], Shao-Hua Lee[3], Wei-Ren Lin[4], Yau-Sheng Tsai[2,5] and Junne-Ming Sung[1,2]

[1]Department of Internal Medicine, National Cheng Kung University Hospital, Tainan, Taiwan, [2]Institute of Clinical Medicine, College of Medicine, National Cheng Kung University, Tainan, Taiwan, [3]Department of Diagnostic Radiology, Chest Hospital, Ministry of Health and Welfare, Tainan, Taiwan, [4]Department of Internal Medicine, National Cheng Kung University Hospital, Dou-Liou Branch, Yun-Lin County, Taiwan and [5]Center for Clinical Medicine Research, National Cheng Kung University Hospital, Tainan, Taiwan

Correspondence to: Junne-Ming Sung; E-mail: jmsung@mail.ncku.edu.tw

ABSTRACT

Dialysis disequilibrium syndrome (DDS) is a rare complication of dialysis, especially with the general application of preventive strategies. Severe DDS with brain herniation is believed to be fatal. We present a patient presenting with bilateral uncal herniation after receiving two dialysis sessions with low-efficiency settings. Serial brain magnetic resonance imaging studies showed the temporal evolution of DDS-induced cerebral edema. With aggressive treatment of hypertonic saline and mannitol, the patient made a remarkable recovery. This case highlights that we should be cautious about this severe complication of dialysis even with preventive strategies, and recovery is possible with prompt recognition and treatment.

Keywords: brain herniation, cerebral edema, dialysis disequilibrium syndrome, end-stage renal disease, hemodialysis, renal replacement therapy

BACKGROUND

Dialysis disequilibrium syndrome (DDS) is a potentially fatal but preventable complication of hemodialysis. The generally accepted theory, 'reverse urea effect', states that the osmotic gradient established by rapid removal of urea and waste by dialysis procedure drives water into the central nervous system (CNS) and causes cerebral edema [1]. Based on the theory, the principal approach to preventing and treating DDS relies on reducing the osmotic gradient by lowering the rate of urea clearance and replacing the plasma osmoles with osmotic active agents [2]. Although the exact incidence of DDS is unknown, the incidence with low-efficiency setting seems to be declining, as preventive strategies are used during initiation of dialysis [3]. Here we present a case of severe DDS-induced brain herniation with unexpected recovery.

CASE REPORT

A 63-year-old woman presented to the emergency department with consciousness disturbance and involuntary movements a

Received: 8.7.2021; Editorial decision: 3.9.2021

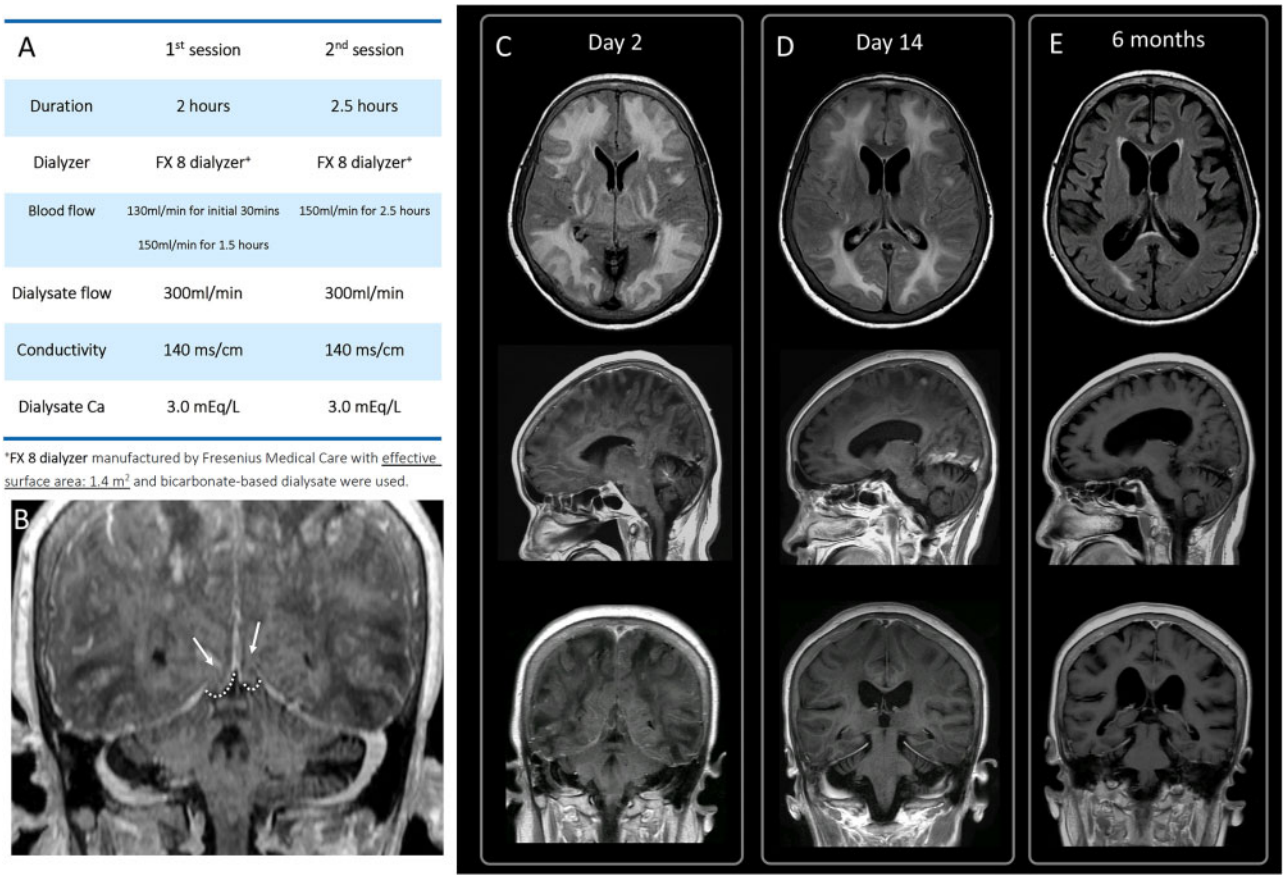
few hours after her second hemodialysis course. Her long-term hemodialysis program was initiated electively 2 days before this episode. The indication for long-term hemodialysis was uremic symptoms of poor appetite and anorexia with a blood urea nitrogen level of 143 mg/dL and serum creatinine level of 10.7 mg/dL. The settings of the first and second hemodialysis are listed in Figure 1A. Her first hemodialysis course was uneventful. However, she experienced an episode of generalized convulsion, which persisted for 1 min, ~2 h after the second dialysis session. Then, she became totally unarousable.

On physical examination, the patient was comatose with Glasgow Coma Scale, E1V1M1 and hypertension 174/94 mmHg. The height and weight were 160 cm and 44.4 kg. A neurological examination revealed bilateral loss of pupillary light reflex, flaccid muscle tone and bilateral pathological Babinski signs. Laboratory investigation showed hypernatremia (147 mmol/L); calcium level of 9.0 mg/dL with ionized calcium level of 1.19 mmol/L; and serum glucose level of 182 mg/dL. Arterial blood gas analysis revealed metabolic acidosis and CO_2 retention (pH, 6.995; HCO_3 level, 13.2 mEq/L; and partial pressure of CO_2, 55 mmHg).

Emergent computed tomography of the head revealed no intracranial hemorrhage. Magnetic resonance imaging (MRI) of the head showed profound cerebral edema with bilateral uncal herniations in T1-weighted images (Figure 1B, arrows). T2-weighted fluid-attenuated inversion recovery (FLAIR) images showed diffuse hyperintensity in the white matter (Figure 1C, upper). Based on clinical presentation and brain images, the tentative diagnosis was life-threatening DDS. The patient was intubated due to hypercapnic respiratory failure. Mannitol 20% (150 mL immediately + 75 mL every 4 h for 5 days) and phenytoin (750 mg immediately + 100 mg every 8 h) were administered, and hyperventilation was initiated for increased intracranial pressure. The third dialysis was performed ~60 h after the second dialysis with immediate intravenous 3% hypertonic saline 300 mL after the third dialysis for prevention of further deterioration of cerebral edema. The sequential change of serum biochemistry and osmolality are provided in Supplementary data (Figures S1–S3). On Day 21, the patient was successfully extubated. Two months later, she was responsive to verbal commands. Six months later, she was oriented and used a walker for ambulation. Serial MRI scans of the head were performed for follow-up, and they showed a dramatic resolution of brain lesions (Figure 1C–E).

DISCUSSION

Due to great variations of symptoms and severity, the prompt diagnosis of DDS is challenging. Although MRI of the head may be normal in mild DDS, it may be helpful in diagnosing severe



A	1st session	2nd session
Duration	2 hours	2.5 hours
Dialyzer	FX 8 dialyzer*	FX 8 dialyzer*
Blood flow	130ml/min for initial 30mins 150ml/min for 1.5 hours	150ml/min for 2.5 hours
Dialysate flow	300ml/min	300ml/min
Conductivity	140 ms/cm	140 ms/cm
Dialysate Ca	3.0 mEq/L	3.0 mEq/L

*FX 8 dialyzer manufactured by Fresenius Medical Care with effective surface area: 1.4 m^2 and bicarbonate-based dialysate were used.

FIGURE 1: (A) Summary of the first two hemodialysis settings. (B) The T1-weighted coronal image showing profound swelling of the brain with uncus sliding over the edge of the supratentorial notch (arrows). (C–E) Serial MRI images on Day 2, Day 14 and at 6 months. (C) T2-weighted FLAIR images (upper) showing diffuse hyperintensity in the white matter; T1-weighted sagittal and coronal images (middle and lower) showing brain swelling and cortical sulcal effacement. (D) MRI on Day 14 showing partial resolution of white matter hyperdensity and recovery of cerebral edema with uncal herniations. (E) MRI obtained 6 months later showing nearly complete resolution of the white matter changes and restoration of the brain anatomical position.

DDS. In this case, MRI of the head revealed brain herniation, cerebral edema and hyper-intensity in white matter, which was compatible with the pattern of demyelination. The case highlights that, even with low-efficiency dialysis and mannitol infusion, severe DDS may happen and cause seizure, coma and brain herniation. In addition, severe DDS with brain herniation had been reported to be fatal [4]. Contrary to the previous report, our patient showed a remarkable recovery after treatment.

To our knowledge, this is the second report in the literature of a patient with DDS-induced brain herniation who survived and recovered [5] and the first case with brain imaging to document the temporal evolution of the DDS. Although previous literature reported that most treatments of DDS were futile, we believe that these patients should receive timely treatment since the build-up of osmotic gradient in the CNS system is transient and self-limiting once the dialysis is discontinued. Administration of osmotic active agents with hypertonic saline and mannitol will raise the serum osmolality and prevent further osmotic shifts. Due to the increasing number of patients receiving hemodialysis, the recognition and treatment of hemodialysis-related complications are paramount for patient safety.

PATIENT CONSENT

Informed consent was obtained from the patient's family to publish this case.

SUPPLEMENTARY DATA

Supplementary data are available at ckj online.

CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

REFERENCES

1. Zepeda-Orozco D, Quigley R. Dialysis disequilibrium syndrome. *Pediatr Nephrol* 2012; 27: 2205–2211
2. Saha M, Allon M. Diagnosis, treatment, and prevention of hemodialysis emergencies. *Clin J Am Soc Nephrol* 2017; 12: 357–369
3. Mistry K. Dialysis disequilibrium syndrome prevention and management. *Int J Nephrol Renovasc Dis* 2019; 12: 69–77
4. Osgood M, Compton R, Carandang R *et al*. Rapid unexpected brain herniation in association with renal replacement therapy in acute brain injury: caution in the neurocritical care unit. *Neurocrit Care* 2015; 22: 176–183
5. Curtis A, Lamb C, Rao H *et al*. Dialysis disequilibrium syndrome and cerebellar herniation with successful reversal using mannitol. *Case Rep Nephrol* 2020; 2020: 8850850